THE DRINKING WATERS IN MARYLAND,

Considered with reference to the Health of the Inhabitants.

BY

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THE DRINKING WATERS OF MARYLAND CONSIDERED IN REFERENCE TO THE HEALTH OF THE INHABITANTS.

BY W. C. VAN BIBBER, M. D.

Within the limits of the State of Maryland, two well-marked divisions of earth-surface are found, that is, high and mountainous land, and low and level plains. There is, consequently, an opportunity to compare these two well-defined sections with each other as to resulting differences in the health of their inhabitants, and to inquire if such differences as may be found can be fairly traced to their water supply.

The boundaries of the State of Maryland are irregular. It lies between the parallels of 37° 53′ and 39° 44′ north latitude, and the parallels of 75° 4′ and 79° 33′ west longitude. The north boundary line of the State is Mason and Dixon's line, which runs nearly straight east and west 196 miles. The Chesapeake bay and the Susquehanna river divide the State into two shores. The western shore is bounded on the west and south by the eastern bank of the Potomac river. The eastern shore is bounded on the east by Delaware and the Atlantic ocean, and on the south by the Pocomoke river and a straight line running from it to the ocean, which line divides it from the eastern shore of Virginia. The longest distance from the north boundary to the water on the south is 120 miles. The State has, therefore, a distance east and west of nearly 200 miles, and north and south 120 miles. Within this irregular boundary there is a land area of 11,124 square miles, and the water area of Chesapeake bay is 2835 square miles. Along the northern line, and for an average of 40 miles from it coming south, the face of the country is mountainous and hilly. The mountains in the northwestern part of the State have a height of 3000 feet, and the hills gradually diminish in elevation from 800 to 300 feet above the level of the sea. Parr's ridge

may be said to be the last of the highlands, in a general way, and south of this ridge the hills are small, most of the land level, and only a few feet above tide. In this way the face of the country is divided into the highlands and the lowlands; and, as physicians, we are familiar with the diseases, as well as with the general appearance of health of the inhabitants of these two parts of our State. The eastern shore and the four lower counties of the western shore border on salt water; and in these counties the lands are flat, having many advantages of agriculture, with, also, additional means of subsistence for their citizens derived from the water. They are considered by many as the garden spots of the State, where not only the comforts of life, but many of its luxuries are easily obtained. It is admitted that ague and fever is more prevalent in the lowlands than amongst the hills and mountains of the State. It is commonly supposed now that the cause or essence of ague and fever is some peculiar principle to be found in the atmosphere of the lowlands. The supposed presence of this disease-germ or poisonous element or essence in the air has given origin to the word "malaria."

Up to this time, every means which has been taken to find the cause of this disease in the air has failed. The microscope has been employed; experiments with ozone have been made; observations of one season differing from another, that is, seasons of drought, seasons of large rain-fall, seasons when storms were frequent and when they were few, have been noted, and yet there is neither a law established nor special object found, so far as the air is concerned, which has given a clew or a tangible form to the cause of ague and fever. The difficulty of the investigation, in all its bearings, is freely admitted; but it may be fairly said, that although the air has been carefully studied, no atmospheric element has yet been found to account for this widely prevalent disease.

It is possible that a study of the drinking waters respectively used in the two sections of the State may hereafter give a more successful result to this most important inquiry. It is partly to direct attention in this way that this paper has been prepared.

In order to understand what differences exist in the waters which are used in this State, or elsewhere, it is necessary to have some standard with which to compare them. Let the standard be pure water, and it will be asked what is pure water? At the present time this is a question not difficult to answer; but it is known that nature does not furnish pure water anywhere in sufficient abundance to be used

by man for the ordinary wants of life. What is the use of water when taken into the system? What are the physiological effects of water? Why and how is water a necessity for the continuance of animal life? These are questions inseparable from this subject. If water is necessary for the preservation of life, and when pure, gives positive results after being taken into the system, then it is fair to infer that impure water, holding many substances in solution, will also give positive results according to the substances held in solution, whatever these may be. Water from every spring, well, stream and river shows some difference in chemical analysis, and we may also infer that each water may give some different result. It is true sometimes these differences both in the water and the result are slight; yet in other instances, and in certain individuals, they are well marked. If such differences are appreciable to chemical tests, they will also be manifested in the condition of the public health, if a contaminated water is used sufficiently long. This subject is an important one, and in the light of recent discoveries in science may give, in any country, a new direction to future researches for the cause of ague and fever, as well as for other diseases. It is not known that what is called in chemistry "pure water" is obtained from any spring or well in this State, but there are said to be a few springs in the world which yield pure water.

Pure water is the starting-point or standard for the chemist when investigating the constituents of such water as is commonly found in nature, or of potable waters supposed to be injuriously impure. How can pure water be obtained? Chemically pure it can only be obtained by carefully managed processes; but practically pure enough for most purposes in chemistry it may easily be obtained, by distilling common water, by catching clean rain water, or by boiling some waters and filtering them. Water thus obtained is pure enough to serve as a comparison for healthy natural drinking water.

It may not be out of place to mention two of the well-known properties of natural water. It passes into steam at a temperature of 212° F., and becomes ice at a temperature of 32° F. Whilst descending from a temperature of about 40° F. to the freezing point it expands with great force. This causes ice to be lighter than water, and it is this, as yet unaccounted-for phenomenon, which preserves all life in the cold and temperate zones. Both the boiling and freezing of water now enter largely into its sanitary study. The purity of ice, when it is to be used for drinking purposes, as will be

seen further on, has recently been brought prominently forward as a matter of great importance.

What are the uses of water in the preservation of life and health? It is the natural drink of all adult animals. In therapeutic phrase it is "a vital stimulus"; and is more essential for the immediate preservation of life than solid aliment or food. Recent experiments of celebrated fasters prove this fact. There are several reasons why water is urgently required for the immediate preservation of life, but a principal one is, that water is required to replace the fluid in the blood which is lost by the excretory and exhaling organs. Without water the blood would become too much thickened to circulate. Water dissolves the various substances taken as food. It forms about 785 parts in 1000 of the blood, and is variously estimated at from $\frac{2}{3}$ to nearly $\frac{4}{5}$ of the entire weight of the human body. "An ordinary healthy adult takes, in one way or another, by eating or drinking, about five pints of it in twenty-four hours. Some more, others less, according to different circumstances and individual peculiarities." This estimate of a celebrated English physiologist is considered more than most persons can comfortably digest of our hydrant or pump waters. "Water is the great means of movement within the system; it performs the same office of transportation and exchange in the vital economy that it does by oceans, rivers and canals, in the commerce of the world. Nutritive substances cannot enter the system, nor the débris of the tissues leave it, except in a state of solution; it is the office of water to bring them into this condition, and convey them to their various places of destination." [Huxley's Elementary Hygiene, p. 370.]

Three things distinguish water, and these are used, in some way, every second of time. It is the most abundant of fluids: when unobstructed, it seeks, in all directions, with amazing force, for the level at which it issued from the earth, and will rest with nothing less than this, or the ocean. Again; it is the only known substance which gives a feeling of freshness to the skin. If there were two or more substances which did this, water would be less remarkable.

The different kinds of water found in Maryland and used by the inhabitants of the State are as follows—they will be treated of in the order named: 1, rain; 2, marsh water; 3, ice water; 4, sea water; 5, mineral water, found within the State; 6, spring water; 7, well water, including artesian wells; 8, stream or branch water; 9, river water; 10, mineral waters, brought by commerce regularly into the

State and sold for table and medical uses. There are no lakes in Maryland, as there are none in what is called the Appalachian range, in which the State is situated. Such is the diversity of earth-surface within the boundaries of the State, that it is difficult to give an average dew-point. Dew differs from rain only in containing a greater amount of atmospheric air.

1. *Rain water* is the purest form of natural water, inasmuch as it has not come in contact with the solid crust of the earth. Notwithstanding this fact, so great is the chemical affinity of water for other substances, that in its descent through the atmosphere it becomes contaminated with ammoniacal salts, chloride of sodium, and organic matters of various kinds in sufficient quantity to be appreciated by tests. Dr. Angus Smith, of England, has written at length upon this subject. Practically, rain water used in this State is not so pure as it might be, mainly because proper care is not taken in catching and preserving it. In those districts where the well or spring waters are "hard," that is, where they will not dissolve soap, rain water is used for laundry purposes. It is then run from the roof-spout into barrels, with no care taken to wash the roof, or to preserve the water clean after it is caught. The one cistern in the city of Baltimore which has been investigated, and which is used for drinking water, is not an exception to this want of care. No precaution is taken to wash the roof before the water flows into the cistern. There are cisterns, however, throughout the State which are said to be kept in good repair and to be properly managed. From these the water is much valued by those who use it. This is particularly the case amongst the wealthy people in the tide-water counties.

2. *Marsh water* is generally impure, from organic matter, of vegetable or animal origin, or both. In salt-water marshes the mineral constituents of sea-water are also present. Marsh-water is not used to any great extent within the State, and never, except upon compulsion, by the inhabitants of the tide-water districts. It should always be avoided as a drinking water, if possible, and ice taken from it should be used *with great caution.*

3. *Ice water* is largely used, especially in summer, but by many persons during the entire year. It stands as a paradox in being at the same time a luxury and a medicine. When ice is slowly melting in pitchers or coolers prepared for the purpose, the coldness of its water makes it pleasant and luxurious; but after it has melted and its water has risen to the temperature of ordinary spring or hydrant

water, its taste is flat, unpleasant and unrefreshing, and then, at this temperature, it is generally rejected as a drink. It is said that fish cannot live in water from melted ice, which at once shows a difference in the vitalizing properties between it and other waters. Water from melted icebergs has been used for drinking in emergencies. It is often said "freezing purifies water," but recent investigations have conclusively proved this is not true to the extent that it is popularly believed. It is true that whilst freezing, water deposits such substances which would give it a specific gravity greater than water itself; but, after sufficient investigations, the most careful biologists are satisfied, that although adult bacteria are killed by freezing, yet the germs of these microscopic animals survive this process, and are afterwards revived, under favorable conditions of moisture in a higher temperature. Thus the question of the impurity of ice has undergone great changes within the last few years, and it is now advised that such water as one would not, and should not, use for drinking, cannot be safely used for this purpose in the form of ice. It is recommended to go even further than this, and to exclude contaminated ice from refrigerators and from meat ice-houses where the meat is brought in contact with the ice. In our State ice is often cut, for domestic uses, from turbid ponds. Such ice should not be used for drinking, but may be used to cool pure water without coming in contact with it. During the summer of 1875 more than twenty-five persons in a hotel at Rye Beach, in the State of New Hampshire, were rendered seriously ill by drinking the water from contaminated ice. This was the first case of the kind which was carefully investigated, and since then many others have occurred, the study of which has added much knowledge to the subject. Experience, therefore, shows that it is important in every household to be careful in the selection and use of ice for drinking and other domestic purposes.

4. *Sea water* is only used for bathing. The sea bath, when properly advised, is an efficient means of restoring deteriorated health. The most esteemed sea-water bathing place in the State is Ocean City, on the Atlantic coast. Tolchester Beach, St. Michael's, Oxford and other places on the Chesapeake bay are used as esteemed salt water bathing resorts.

5. *Mineral Waters found within the State.*—When the saline or gaseous ingredients of water are sufficient in quantity to impart to it a decided odor or taste, or when, from their analyses, or from experience, spring or well waters are found to contain substances which

produce positive beneficial results upon some of those who drink them, they are termed mineral springs. Of these there are many in the State which are used for medicinal purposes. The water from one well has recently obtained much celebrity as a mineral water. This is the Strontia water, and the well from which it is obtained is situated near Brooklandville, in Baltimore county. Its analysis has been made by Prof. Wm. Simon, and shows that this water contains more strontia than any other water known. It is highly esteemed by many physicians and others who have used it. What the particular medical virtues of strontia are, or how this substance, in combination with other substances, gives such positive results as this water does in some cases, are questions which cannot be discussed in this paper. There are many chalybeate, sulphur and limestone springs throughout the State having local reputations as mineral waters; but none which are used to any great extent as popular resorts, and none other than the strontia which is sold in sufficient quantity to deserve mention.

A brief consideration has been given to rain, marsh and sea water, and mineral waters found within this State, because these are comparatively little used for general purposes. The inhabitants of the State depend for their daily water supply upon springs or wells, and streams and river water. About one-half of the inhabitants of Maryland use the former, and the other half the latter. The cities of Baltimore, Frederick, Hagerstown and Cumberland have already, or are now constructing, systems of water supply, which will bring the water from neighboring rivers or streams into the houses of the residents of those cities. Cumberland, in this State, and Washington city, in the District of Columbia, are supplied from the Potomac River.*

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*The city of Washington was originally in the State of Maryland. The following statistics of its water supply may be interesting, and have been furnished for this paper, by the kindness of Thomas P. Morgan, Esq., one of the Commissioners of the District of Columbia:

WASHINGTON, *April* 5, 1882.

TO THE ENGINEER COMMISSIONER, D. C.:

Sir:—In reference to communication of Dr. W. C. Van Bibber, addressed to Com'r Morgan, I have the honor to report the following answers to inquiries therein:

Question 1. *Answer.*—The original ordinance concerning the care and management of the Water Works of Washington imposes fine and imprisonment for injury to any of the structures or appurtenances.

Hagerstown is supplied from the water-shed west of South Mountain, and Frederick from the water-shed east of South Mountain. It will be a source of general regret to you, as physicians, and to the people of the entire State, to read in the valuable report of the State Board of Health for this year, concerning the bad condition of the water supply in Cumberland and Frederick. It is only necessary to refer to this report for all that can be said upon the subject. It is to be hoped the prominent men in these two cities will take those means, which are so easily within their reach, to remedy this public evil in their communities, without delay. The water supply of Hagerstown is reported as good.

Question 2. *Answer.*—The present supply is about 27 million gallons per day, which cannot be greatly increased without extension of works.

Questions 3 *and* 4. *Answer.*—There is no considerable amount of storage, the natural flow of stream being relied on.

Question 5. *Answer.*—The present supply is at the rate of about 170 gallons per day per capita.

Question 6. *Answer.*—An analysis made in 1875 gave in grains per gallon: Chlorine, 0.17543; Ammonia, 0.000584; Albuminoid Ammonia, 0.003625; Hardness $10\frac{4}{10}$ degrees of Clark's scale.—Analysis by Surgeon Gen'l U. S. A.

Question 7. *Answer.*—In purity it ranks as compared with water of other cities in the country.

Question 8. *Answer.*—Muddy after heavy rains. No disagreeable taste or odor of late years.

Question 9. *Answer.*—Has occurred in hot weather, attributed to microscopic vegetable growth on surface of water at Great Falls.

Question 10. *Answer.*—Natural flow or gravity supply. About 3 million gallons per day pumped by steam power for high service.

Question 11. *Answer.*—Distributing reservoir 146 feet above tide-water.

Very respectfully,

GEO. H. BAILEY, *Computing Engineer.*

ENGINEER DEPARTMENT, D. C.
WASHINGTON, *October* 9, 1880.

Analysis of water from Potomac River, at Police headquarters. One litre=1000 grammes of this water:

Appearance, clean, no taste, no odor. Hardness, 2 degrees, each degree= 0.00548 $CaO.CO_2$. Solid Residue, 0.048. Organic Matter, 0.025. Free Ammonia, 0.00013. Albuminoid Ammonia, 0.00010. Nitrates Nitrites, traces. Chlorine, 0.006. Mineral Substances, 0.023. Microscopic Examination, nothing visible by microscope.

Opinion—Good water.

G. J. DE SMEDT, *Chemist.*

6. *Spring and Well water.*—The country residents of Maryland depend for their supply of water upon springs and wells. Owing to the peculiarities of the State, it is proper, in the beginning, to define "what is a spring?" and to distinguish it from a well. There are surface springs, deep springs, ascending, descending and intermittent springs within the State; but the difficulty is to define what is a well; as in certain situations in the alluvial lands, water is found near the surface of the earth, but not flowing over it. To settle this point, let us call that a well when the water is found three feet below the surface of the earth, and a spring when at a less depth than this.

The water from all springs and wells differs from rain water, owing to the solution of certain substances found in the crust of the earth through which the water has percolated. The nature and amount of such substances held in solution must vary with the nature of the strata through which the water has passed. The salts which are commonly held in solution in spring or well waters are the car-

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ENGINEER DEPARTMENT, D. C.,
WASHINGTON, *July* 29, 1881.

Analysis of water from Potomac River taken at my laboratory. One litre= 1000 grammes of this water:

Appearance, turbid, no taste, no odor. Hardness, 2 degrees, each degree= 0.00548 $CaO.CO_2$. Solid Residue, 0.090. Organic Matter and Volatile, 0.096. Free Ammonia, 0.00010. Albuminoid Ammonia, 0.00013. Nitrates Nitrites, traces. Chlorine, 0.007. Mineral Substances, 0.034. Microscopic Examination, infusoriæ, mineral and vegetable debris.

Opinion—Good water.

G. J. DE SMEDT, *Chemist.*

ENGINEER DEPARTMENT, D. C.,
WASHINGTON, *April* 6, 1882.

Analysis of water from Potomac River at my laboratory, Police headquarters. One litre=1000 grammes of this water:

Appearance, turbid, no taste, no odor. Hardness, 2 degrees, each degree= $CaO.CO_2$ 0.00548. Solid Residue, 0.062. Organic Matter and Volatile, 0.020. Free Ammonia, 0.00012. Albuminoid Ammonia, 0.0001750. Nitrates Nitrites, 0.002. Chlorine, 0.006. Mineral Substances, 0.040. Microscopic Examination, infusoriæ, mineral and vegetable debris.

After having been filtered through charcoal:—Appearance, brilliant, clear, no taste, no odor. Hardness, 2 degrees. Solid Residue, 0.032. Organic Matter and Volatile, 0.008. Free Ammonia, 0.00012. Albuminoid Ammonia, 0.00007. Nitrates Nitrites, 0.002. Chlorine, 0.006. Mineral Substances, 0.024. Microscopic Examination, nothing visible by microscope.

Opinion—Good water.

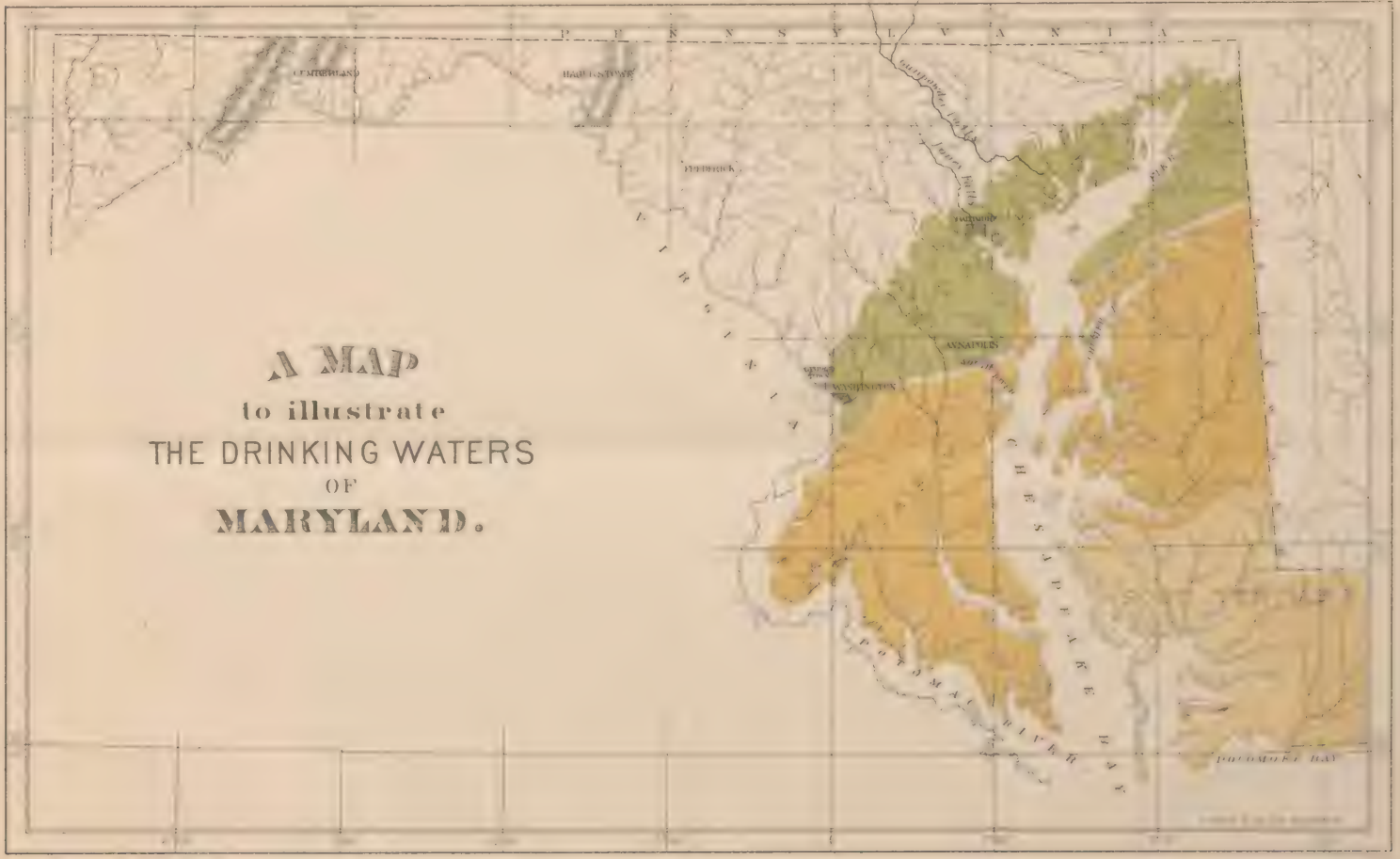
G. J. DE SMEDT, *Chemist.*

bonates of lime, magnesia, iron and manganese, the sulphates of lime and magnesia, besides other carbonates, sulphates, nitrates or silicates. When any of these are present in sufficient quantity to prevent the solution of soap, then such spring or well water is termed "hard," and cannot be used for laundry or some other domestic purposes. It is also termed "limestone water" throughout the country, and when used for drinking by some individuals it causes an acute and violent trouble of the digestive organs. Those who have this idiosyncrasy must avoid limestone waters. Spring and well water that will dissolve soap is called "soft" or freestone water. This is highly prized, as good for all purposes, and does not produce any disturbance of digestion.

An examination of the geological map drawn by the former State geologist, the late Philip Tyson, in 1859, to illustrate his report upon the geology of the State of Maryland, will show the variety of strata, the number of minerals and other substances found in the crust of the earth in Maryland, and a more detailed examination of it will explain the cause for the variety of waters found in springs and wells throughout the State. This map shows twenty-four different colors, each color designating a different geological formation or subterranean substance. It further shows that these diversities of formations are all in the northern or hilly part of the State. The southern part of both shores, that is, from the head waters of Chester river to Pocomoke bay on the eastern shore, and from South river to Point Lookout on the western shore, the land is homogeneous and of tertiary and post-tertiary formation. The map here presented is reduced from Mr. Tyson's larger one, leaving out the various colors designating the geological formations in the northern part of the State, and shows his survey of the alluvial portions of the State, and his boundaries of its cretaceous, tertiary and post-tertiary formations.

It is upon these level plains that cases of ague and fever are most common. The important question to be considered is, why is this disease more frequent in the flat country? North of the cretaceous belt, and diminishing in frequency in going north, indigenous ague and fever is the exception. How shall these well-known facts be explained?

Should any one undertake to answer this question now, he would probably say "malaria" was the cause of the distinctive and prevailing disease found in the country of the tertiary or alluvial formations. The immediate inference would be, that the atmosphere covering the


A MAP
to illustrate
THE DRINKING WATERS
OF
MARYLAND.
PENNSYLVANIA
CUMBERLAND
HAGERSTOWN
FREDERICK
ANNAPOLIS
WASHINGTON
CHESAPEAKE BAY
POTOMAC RIVER
POCOMOKE BAY

mountains and hills was better than that covering the low lands. It has already been said that the toxic principle producing ague and fever has not been demonstrated as existing in the air: yet the reasons advanced for supposing it to be in the air are good reasons; but it would be a great satisfaction, and a valuable step in advance, if one was able to be more precise.

The mass of the inhabitants of the alluvial counties use spring and well water. How do the waters in the two sections of the State differ as to their sources? In the hills and mountains, the wells and springs are supplied by subterranean streams and basins. In the level lands the water in wells and springs may have three different sources. Rain, sinking into the crust of the earth, forming streams and basins underground, is one source: deep streams coming from the primal formations may be another: a third source is the percolation and filtration of salt water through the soil from the ocean and bay. At some distance from the shore, in alluvial soils, there is a water-line below the crust of the earth, where, at a certain depth, the water fluctuates with the tide. This is now a matter of common observation; although, long ago, when Cæsar demonstrated it at the siege of Alexandria, he received great praises for his sagacity. A notable instance of this tidal water line was shown whilst the foundation for the Safety Deposit Building in Baltimore was being excavated: and thousands of our own inhabitants, living along the shores of the Chesapeake bay and the rivers emptying into it, know the fact by the brackish water in their springs and wells. The amount of potable water furnished from this source along the coast line of the State must be large, because, calculating the sinuosities from the bay, rivers and ocean, the water line is long, and the soil upon the shores is of a character easily permeated by fluids. This will account for the contamination of the water in some places, which varies in degree from that which is barely perceptible to that which is unfit for drinking purposes. This source of water supply constitutes the most marked difference which can be found between the waters in the two sections of the State; and if this difference in the water is ever demonstrated to be a factor in the production of fever and ague amongst the inhabitants of the alluvial portions, all preconceived ideas of this disease as to its cause, prevention or cure, will be changed. Investigation and study are necessary to determine this point.

As a commencement or introduction to future study, the length of the tide-water line has been measured. It will be interesting, to those curious upon the subject, to have its measurement furnished to them by counties. This has been done, for this paper, by the kindness of the Superintendent of the United States Coast and Geodetic Survey office, in Washington. His report is given entire.

U. S. Coast and Geodetic Survey Office,
Washington, *March* 22, 1882.

Dr. W. C. Van Bibber.

Dear Sir:—In compliance with your request, the following table, showing the length of the tide-water coast of Maryland, by counties, has been prepared in this office.

For the purpose of making the required measurements, the limits of the counties were first marked upon one general small scale chart, in order to give a general view of the water lines. The counties having water limits were again indicated upon our large scale charts, and a slightly generalized course traced along the shores of the rivers and creeks, and then measured in steps of one-fourth mile.

Length of the Tide-water Coast of Maryland.

[Atlantic Ocean, Chesapeake Bay and its rivers on both sides, and East Bank of the Potomac River and its branches.]

		Statute Miles.
Atlantic Coast, Worcester County,		32
Chesapeake Bay, East Side,		
Somerset County, including marsh islands,	387	
Dorchester " " " "	407	
Talbot " " " "	364	
Queen Anne " " " "	211	
Kent " " " "	190	
Cecil " " " "	136	
East Side,	1695	
Chesapeake Bay, West Side,		
Harford County, including marsh islands,	111	
Baltimore " " " "	179	
Anne Arundel" " " "	275	
Calvert " " " "	130	
St. Mary's " from Benedict (Patuxent River) to Pt. Lookout,	88	
West Side,	783	
Chesapeake Bay,		2478

EAST BANK OF POTOMAC RIVER.

St. Mary's County.	From Point Lookout to Bird Creek, on the Wicomico River, . .	183	
Charles "	From Bird Creek to Marshall Point .	106	
Prince George "	From Marshall Point to Oxon Creek (D. C. Boundary)	16	
	East Bank Potomac River . .		305
Atlantic Coast and Chesapeake Bay and East Bank Potomac River. Total			2815

The charts upon which these measurements were made can be seen at this office, at any time.

Yours respectfully,

J. E. HILGARD, *Superintendent.*

As the measurement of our coast-line by counties and its total length have not been calculated and published before, many of our citizens, and others, will be surprised to find that the tide-water coast line of the State of Maryland is nearly equal in length to the average width of the Atlantic ocean, which is given by geographers at 3000 miles.

What application can reasonably be made of this information? The great length of the tide-water coast-line, and the increasing prevalence of ague and fever as it is approached, are two facts which, when placed in juxtaposition, naturally suggest cause and effect. The effect is admitted; the cause remains a problem. Some years ago, Mr. Blower, of Bedford, England, called attention to the fact that the real source of ague and fever might be found in the drinking water, and not in the air, as was then, and is now, generally supposed.* The discovery which has been made by M. Pasteur, and which is at present exciting much interest, gives additional encouragement to prosecute this line of study. If there are disease-germs which do not die, but which are to be found by the microscope, long after being buried in the ground, then it is by no means improbable to suppose that drinking-water, percolating through alluvial soils, may be as likely as any atmospheric poison to convey a disease like ague-and-fever into the system.

There are other facts in this connection which will claim the attention of any one who will undertake its study. A few of them may be mentioned. There are situations along the tide-water coast-line, and also in the tertiary formations distant from it, where ague and

* More recently, other discoverers have investigated this subject—Klebs, Tomassi and others.

fever does not originate. Those who live in these situations, and who have not had ague, present an appearance of health equal to the best specimens of vigor found in any other part of the State or country. This fact might be accounted for, either by supposing that there are certain individuals who are not readily affected by air-poisons, or upon the supposition that the poison is not in the air. On the other hand, there are persons, mostly engaged in labor deep in the swamps of the peninsula, such as the cypress shingle-makers, who have a sickly appearance different from any other men in the State. Ague and fever is the rule with them. They have the bronzed liver and the enlarged, soft spleen. It is supposed now that their disease has its origin in the air; but no student coming fresh to the study of cause and effect would be willing to take this for granted. Both air and water are the common supporters of life, the one as much as the other. Both form combinations within the body which renew the blood. But if either one of them alone conveys this disease into the body, it is done by a different route and in a dissimilar way. If ever this question is definitely solved, and drinking water is demonstrated to be the conveyer of the poison, then fever and ague will be prevented and cured by a different means from that which is now used.

8. *River-water*, or, as it is called with us, stream or falls-water, may properly be regarded as a mixture of rain-water and spring-water, plus the mud on the cultivated portion of the water-shed over which the water flows, and the detritus in the bed of the streams through which the water passes. The impurity of the water is more influenced by these two latter circumstances than by any other causes. Where river-water is used there is a necessity for its purification before it is fit for drinking and other domestic purposes. This is effected by storage in the first place, and the purification may be further improved by filtration and boiling. The hydrant-water of this city, which is first filtered, then boiled and cooled, is so much improved that it is worth all the trouble taken to effect these three processes.

The census of 1880 has given the population of Maryland, in round numbers, at 935,000. It would be fair for our legislators to estimate that nearly one-half of the population of the State live on the water-sheds, or use the collected waters of two streams, viz. Jones' falls and Gunpowder falls.

The chief engineer of the water supply of Baltimore has kindly furnished for this paper replies to certain questions concerning these streams, which, when read, will explain themselves.

WATER DEPARTMENT, CHIEF ENGINEER'S OFFICE, CITY HALL,
Baltimore, March 18, 1882.

W. C. VAN BIBBER, M. D.:

Dear Sir—Please find answers to some of your questions:

1. Capacity of Gunpowder works in 24 hours, 170 millions gallons. Now coming from Gunpowder in 24 hours, from 8 to 10 millions gallons.

2. Capacity of Jones' falls in 24 hours, 30 millions gallons. Now coming from Jones' falls in 24 hours, 8 to 10 millions gallons.

3. We never have been able to determine accurately our consumption, but I think it safe to say that we use from 16 to 20 millions gallons; that is, 20 in warm weather and 16 in cold. Then take population supplied at 400,000 and you will have the per capita.

Very respectfully, &c.,

ROBERT K. MARTIN,
Chief Engineer.

If the population of Baltimore, with its residents and strangers, is estimated at 400,000, which is a large estimate, the full capacity of the two streams will furnish 500 gallons to each person in twenty-four hours. This is a large water supply, being 499 gallons more per man per day than is furnished to each person on board ship in the United States navy. It is believed that Baltimore has now the largest proportional water supply of any known city.

If the supply is so abundant it is interesting to know something of its quality before being collected, and of its management when collected, from these two streams. For the investigation of the quality of river water in general, the Report of the Medical Commission upon the sanitary qualities of different river waters, made to the city of Boston in 1874, gives the following points for observation, viz:

"1. The nature of the soil and the configuration of the land where the rivers rise and flow; color, taste and general appearance of the water; sources of pollution; sewage; manufacturing refuse; density of population in drainage areas; chemical composition of the water, and its storage." To this might be added drainage from lands enriched by fertilizers.

The water-shed of Jones' falls has been surveyed in regard to these facts and reported upon; that of the Gunpowder falls has not. The headwaters of Jones' falls are in Baltimore county. The stream flows through the Green Spring valley; the towns of Lutherville and Towsontown are on its water-shed, and the first storage of its water for the use of the city of Baltimore is at Lake Roland. After this it has three storage lakes, the principal one of which is Druid Lake in Druid Hill Park. Analyses of its water have been made by Drs.

David Stewart and R. Buckler, and by Profs. Campbell Morfit, Tonry, and Ira Remsen. The water-shed of Gunpowder falls extends over a wide range of country through Baltimore and Harford counties and into Pennsylvania. Analyses of its water have been made by the same persons. The water from the Gunpowder falls is considered to be better than that from Jones' falls by all the analysts. For the details of their opinions it is only necessary to refer to the analyses which have been mentioned; they are omitted from this paper, because they are already on record and can easily be referred to.*

The color, odor and taste of river-water are subject to changes. After hard rains during any season, small streams like Jones' falls and the Gunpowder become muddy; but during the thaws of spring this condition is worse than at any other time. The amount of contamination in the water varies with the particular circumstances of each spring. The impurities of river-water may be of two kinds, mechanically-suspended impurities and impurities held in solution. The former can be got rid of, to a considerable extent, by subsidence during storage; the latter can not be got rid of in this way, but only by some other process, as by distillation, or a chemical reaction.

The changes in taste and odor of river-water generally appear together. Where there is a disagreeable taste, there is, accompanying it, an unpleasant odor, and *vice versa*. The causes of these changes are often difficult, or it may be impossible, to determine, because they may depend upon soluble impurities. An illustration of the change in taste and odor of water occurred in Baltimore, Boston and other places last year. On the 19th of January, 1881, a disagreeable taste and odor were observed in the hydrant water of Baltimore. Public attention was aroused. The change was remarkable for its appearance in midwinter, and for its shifting from one section of the city to another. Explanations were freely offered as to the cause of this change, by every citizen who considered himself competent to the task. Finally, the public-spirited proprietors of the *Sun* newspaper

* At the time of writing this paper there was a bill before the Legislature of Maryland, then in session at Annapolis, for protecting the purity of the Gunpowder water supply. There was every expectation that the bill would be made an operative law by the Legislature of 1882. But notwithstanding the fact that far more than one-half of the inhabitants of the State use the water from these two streams some time during the year, and nearly one-half of the population use it as a constant water supply, the bill was not passed. Why not? Let those interested read the Legislative debates on this subject.

secured the services of Professor Tonry, and the Water Board those of Professor Remsen, to study the difficult subject, and report. Professor Tonry gave his opinion, formed from his analysis, that "the objectionable taste, odor and peculiar milky color of the Jones' falls water were due to the decomposition of the sulphates, held in solution, passing into the sulphites, and setting free sulphuretted hydrogen gas." The change in the water continued until the middle of April, when it disappeared.

Professor Remsen, of the Johns Hopkins University, reserved his opinion, as to Baltimore, and was afterwards engaged in a similar investigation for the city of Boston. He arrived in Boston on the 4th of November last, and gave his opinion concerning the water of that city on the 19th of the same month.* The paper in which the opinion is contained is comprehensive, and embodies the facts known upon the subject to its date. No abstract can be made that will do it justice. The satisfactory conclusion to which Professor Remsen brought his investigation is, that the peculiar condition of the water in Boston in November, 1881, was due to the presence of the "Spongillia Lacustris," one of the fresh-water sponges. After describing in detail the steps by which he made this discovery in Boston, Professor Remsen says, "I have good reason to believe that the contamination of the Baltimore water was of the same nature as that with which we are at present dealing, viz. the Boston water." Encouraged by his success in that city, he will, no doubt, be requested to continue his investigations here.†

It is desirable, on sanitary grounds, that the drinking-water of a city, where, besides its citizens, more than half the country population of the State assemble some time during the year, and where

* "Report of the Joint Standing Committee on Water, on the impurity of the water supply, with the report of Professor Ira Remsen on the subject." Boston, Rockwell and Churchill, City printers, No. 39 Arch St. 1881.

† June 14th, 1882, Baltimore. While this paper was passing through the press, another instance of unpleasant taste and odor in the water has occurred in Baltimore. It commenced on the 1st of June in the eastern portion of the city, and the trouble was traced without much difficulty to Lake Montebello, one of the Gunpowder storage lakes. The taste and smell of the water were peculiarly nauseous. When the water was found to be clear in Loch Raven (the lake at the dam on the Gunpowder falls), it was passed directly into the city, thus leaving the two storage lakes to be examined at leisure. This admirable arrangement gives ample opportunity to investigate the cause of the trouble. The disagreeable odor and taste of the water disappeared on the 9th of June.

strangers come for business and pleasure, should be protected by law from any kind of filth or refuse matter. This principle plainly applies to Baltimore, but the citizens of Frederick and Cumberland require legislation in this respect also.*

Our citizens have been urged to abandon the pump waters within the Baltimore city limits, and use the hydrant water, the cost of which has been reduced. The recent Health Commissioner had the water from 100 pumps and springs analyzed by Professors Remsen and Tonry, and published the results of their analyses. It has been advised, by different Boards of Health, to condemn all waters holding in solution or suspension more than 50 parts of solid contents in 100,000 parts of water. The International Medical Congress at Brussels put the standard at 85 grains to the gallon. Water from one of the pumps in the city was found to contain 207 parts to the 100,000. Others contained less, as 158.5, 130.2, 99.5, &c. Those pumps not coming up to the proper given standard for healthy drinking water were condemned and dismantled. This most valuable work is still going on under the direction of the present Health Commissioner. When it is known that there are over 80,000 nuisance sinks and wells at various levels within the city limits of 9600 acres, no one will wonder that the pump waters within this area, and even beyond it, should be contaminated.

In smaller towns also throughout this State, as Cambridge, Westminster, Easton, and many others, the water from the different pumps throughout the towns should be often and closely examined. The presence of nuisance sinks in the neighborhood of a well or spring used for drinking water must always be regarded with suspicion, and never be permitted to remain without thorough investigation. Even in country residences carelessness in this respect has been known to produce the saddest consequences, by causing such diseases as typhoid fever, diphtheria, &c.

* "No sewage of any kind, whether purified or not, should be allowed to enter any pond or stream used for domestic purposes. There should be absolute prohibition in all cases against casting sewage or filth of any kind into any stream or pond used as a source of water supply. Where such conditions now exist the sewage or filth should be diverted to some other channel. For, until our knowledge has so far advanced as to enable us to recognize 'germs' of disease, and to destroy them effectually by some simple and easy process, even purified sewage must be looked upon as a dangerous addition to drinking-water."—*General Report of Mass. Board of Health*, 1876, p. 112.

10. *Mineral Waters brought by commerce into the State from other places*, for table and medicinal uses, and sold for the most part at moderate prices, are principally as follows: "Deep Rock" from Oswego county in N. Y.; last year the agent for this water sold 70,000 gallons. Bedford, from Penn.; Strontia, from Md.; Rock Enon, from Va., Massanetta and many others from the same State; Congress, Hathorn and Geyser, and others of different medicinal virtues from Saratoga; Clysmic, from Wis.; Summit, from Maine; Apollinaris, Rhens, and others from Europe. These are a few, selected out of many, that now find remunerative sale in this city and throughout the State.

In life there are always fashions, and at present these are at hightide, and cannot rest so long unchanged as they did years ago, when communication and transportation were more difficult and expensive. The custom, or fashion, of furnishing pure drinking water for table, family or medical uses, in bottles, at moderate cost, to the inhabitants of cities where pure spring water cannot be obtained, is daily increasing in this country and in Europe. The commerce in the commodity of water is growing, and increasing in favor and in importance. Any one who will visit a store established for this purpose, and see the facilities for handling large quantities of water, will form some idea of its extent. The waters coming from this country are for the most part received in barrels; they are then bottled, carbonized when desired, corked, wired and labeled, and furnished at a much less cost than beer or ale. *We*, as physicians, know they are less injurious than any alcoholic mixture. It is hoped that soon, under the liberal management of this commerce, aided by the educated classes of the city and State, together with the temperance movement, plain and carbonized waters will be furnished to the young people in our cities and towns in gardens more attractive than the German lager beer grounds.

The substitution of cooled, or carbonized water, selected from choice springs, and presented in bottles, instead of malted or stronger alcoholic drinks, would inaugurate an era of reform and improvement in feelings and habits among our citizens. Compared with these stimulating drinks, water can be furnished at less cost, and in greater variety. It is certainly more healthful, strengthening and delicious; leaving behind no headache, bloat or intoxication. Nothing, in this or any other State, will suffer from such a change, but the criminal courts, the penitentiaries, and early deaths.

"Water," says Dr. Hoffman, "is the fittest drink for all persons, of

all ages and temperaments; of all the productions of nature or art it comes nearest to that universal remedy so much searched after by mankind, but never discovered. By its fluidity and mildness it promotes a free, equable circulation of the blood and humors through all the vessels of the body, upon which the due performance of every animal function depends; and hence, water drinkers are not only the most active and nimble, but also the most cheerful and sprightly of all people. . . . . And as to the different ages, water is good for children, to make their tenacious milky diet thin and easy to digest; for youth and middle age, to sweeten and dissolve any scorbutic acrimony or sharpness that may be in the humors, by which means pains and obstructions are prevented; and for old people, to moisten and mollify their rigid fibres, and to promote a less difficult circulation through their hard and shrivelled vessels."

That the purity of drinking-water is of the greatest importance to the health of every community no one will seriously deny. In the rural districts, in the northern part of this State, one may drink without fear from the spring which gushes from the ground; but when a dense population pollutes the natural strata of the earth, as in our cities; when industrial pursuits tend to contaminate streams, as in the neighborhood of manufactories; when necessity compels men to live where the water supply is poor, and possibly a source of ill health, then the office of investigator and protector becomes imperative. In this connection permit me to recall to your recollection what has been already written by two of our most distinguished members, whose sentiments, no doubt, we will endorse. "State Medicine," says Prof. Samuel C. Chew, "presents the broadest and noblest field in which medical science and art can work for the welfare of mankind; for the object to which it opposes itself is not merely disease as it occurs in individuals, but as it extends over wide areas and threatens multitudes." "Moreover," says Prof. Richard McSherry, "all the water sources in the State intended for the consumption of the inhabitants ought to be subject to the supervision of the State Board of Health, aided by a competent chemist; and as Baltimore to the other cities, so may Maryland be to the other States, at once the most attractive and most salubrious of them all."

Water, as it is supplied by nature, upon or under the crust of the earth, in our own State or elsewhere, depends for its purity, and its proper and abundant distribution, after it has been collected for the

use of cities, upon so many circumstances, that the entire subject demands much study, embracing as it does so many varied points of knowledge. Experience must lend her aid to correct any existing opinions which may be erroneous, and also to direct further improvements in machinery where they are required, and practical operations of every sort. This paper has been prepared, amidst many interruptions, in order to make a beginning in this study, and also to give what information can at present be collected from different sources concerning the various waters found in the State of Maryland, and at the same time to advise how they may sometimes be improved; how the waters in our streams, used for the benefit of the public, may be kept pure, and still further purified when it is required; what other waters, brought from different places, may be beneficially substituted for our own, both in private and public use; and also to show which of the waters of the State should be avoided.

Water may be improved by chemical means, by subsidence, filtration, and sometimes by boiling. To keep the water pure in those streams which are to be used for the public is an obligation similar to the duty and interest which each man has to preserve his own health and that of his family. The commerce in water brought from springs in or out of the State, which has fairly commenced, deserves patronage and extension. It would be an advantage to the State if our young people and pleasure-seekers could be induced to use pleasant waters uncontaminated by alcohol. The waters to be avoided are those from springs which are injurious to certain individuals, and ice taken from ponds which are not considered pure enough to be used for drinking. If this paper should be the means of meeting the requirements for which it was intended, there are those amongst us who are amply able to carry on the important study. The State of Maryland, although small in extent, has singular diversity of surface and great resources; the development of these is a common obligation and a common benefit. This Society presides over the fountain-head of its greatness, which is health; and for the proper management of its waters, and the purification of its air, the citizens naturally look to you.